Claims

[c1] 1. A method for forming an opening, comprising:sequentially forming a material layer, a patterned protective layer and a photoresist layer on a substrate;performing a first exposure step to form a line/space image on the photoresist layer with a first exposure dosage lower than a sufficient exposure dosage required for development;performing a second exposure step to define a region to be removed in the photoresist layer with a second exposure dosage lower than the sufficient exposure dosage, while a sum of the first and the second exposure dosages is equal to the sufficient exposure dosage at least;performing a development step to remove the photoresist layer in the region to expose a portion of the patterned protective layer and a portion of the material layer; andperforming an etching process to form an opening in the material layer by using the photoresist layer and the patterned protective layer as a mask.

[c2] 2. The method of claim 1, wherein the patterned protective layer comprises strip protective layers.

[c3] 3. The method of claim 2, wherein an orientation of the line/space image is perpendicular to an orientation of the strip protective layers.

[c4] 4. The method of claim 1, wherein an etching rate of the patterned protective layer is lower than an etching rate of the material layer in the etching process.

[c5] 5. The method of claim 1, wherein the patterned protective layer comprises silicon nitride or silicon oxide.

[c6] 6. The method of claim 1, wherein the first exposure dosage is equal to one half of the sufficient exposure dosage.

[c7] 7. The method of claim 1, wherein the second exposure dosage is equal to one half of the sufficient exposure dosage.

[c8] 8. The method of claim 1, wherein the first exposure step uses an off-axis illumination.

[c9] 9. The method of claim 1, wherein the second exposure step uses an off-axis illumination.

[c10] 10. The method of claim 1, wherein the photoresist layer comprises an i-line photoresist or a deep-UV photoresist.

[c11] 11. The method of claim 1, wherein the opening has a rectangle or square shape.

[c12] 12. A method for fabricating a Mask ROM, comprising:forming a plurality of buried bit lines in a substrate;forming a gate dielectric layer on the substrate;forming a plurality of strip protective layers over the buried bit lines;forming a plurality of word lines on the substrate perpendicular to the buried bit lines;forming a photoresist layer on the substrate covering the word lines;performing a first exposure step to form a line/space image on the photoresist layer with a first exposure dosage lower than a sufficient exposure dosage required for development, wherein an orientation of the line/space image is different from an orientation of the strip protective layers;performing a second exposure step to define a plurality of regions to be removed in the photoresist layer with a second exposure dosage that is lower than the sufficient exposure dosage, while a sum of the first and the second exposure dosages is equal to the sufficient exposure dosage at least;performing a development step to remove the photoresist layer in the regions to expose selected channel regions and a portion of the strip protective layers, while a plurality of coding windows are defined by the strip protective layers and the photoresist layer; andimplanting coding ions into the selected channel region with the photoresist layer and the strip protective layers as a mask.

[c13] 13. The method of claim 12, wherein an orientation of the line/space image is perpendicular to an orientation of the strip protective layers.

[c14] 14. The method of claim 12, wherein the strip protective layers comprise silicon nitride or silicon oxide.

[c15] 15. The method of claim 12, wherein the first exposure dosage is equal to one half of the sufficient exposure dosage.

[c16] 16. The method of claim 12, wherein the second exposure dosage is equal to one half of the sufficient exposure dosage.

[c17] 17. The method of claim 12, wherein the first exposure step uses an off-axis illumination.

[c18] 18. The method of claim 12, wherein the second exposure step uses an off-axis illumination.

[c19] 19. The method of claim 12, wherein the photoresist layer comprises an i-line photoresist or a deep-UV photoresist.

[c20] 20. The method of claim 12, wherein each coding window has a rectangle or square shape.